THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[THIRD SERIES.]

No. 96. DECEMBER 1865.

XLII.—*On the Systematic Value of the Organs which have been employed as Fundamental Characters in the Classification of Mollusca.* By Dr. O. A. L. Mörch.

Whether classes, orders, and genera are founded in nature, or are only artificial divisions, is a question rarely disputed. It is, however, still a matter of discussion whether now-existing species are direct descendants of extinct forms from remote geological periods, which have been gradually changed in the course of natural selection or in consequence of physical changes of the globe, or are entirely new creations of any one geological era. The habits of an animal often cause a considerable modification of the external form, size, or colour, which are often improperly considered of specific value; but it must be admitted that such differences are subject to limits which cannot be passed, and do not become hereditary. For instance, the corns of the human foot are, like the nails, a thickening of the epidermis; but the former are produced by accidental pressure on the foot, while the latter originate in the fœtal structure of the animal. There is the same distinction between false and genuine species.

Linné divided all creation into three kingdoms—animal, vegetable, and mineral. The last-named division is less logical, because minerals can only be considered as parts of the great celestial bodies, which may be regarded as inorganic beings with involuntary motion impressed upon them, corresponding with that of the heart or stomach of animals. Geoffroy St.-Hilaire has more correctly made the division into phanerobiotic and cryptobiotic kingdoms. A predestined scheme is shown in the chronology of our planet as well as in the development of organic beings. Thus the oceans with their lower types are regularly in course of time changed to islands and continents with their

higher terrestrial types. Even the form of the now-existing continents seems to be subject to a certain definite plan. The three main continents (1. Europe and Africa, 2. North and South America, 3. Asia and Australia) extending from north to south, nearly forming a continuous range, show a remarkable resemblance in their configuration—towards the south a large triangular mass of land without considerable gulfs (Africa, South America, Australia) united by an isthmus (Suez, Panama, Malacca and Sunda islands) to a larger land with numerous gulfs and peninsulas, forming a large median gulf (the Mediterranean Sea, the Gulf of Mexico, Mindoro Sea) with numerous archipelagos at the entrance (Canarian and Cape de Verde Islands, West-India Islands, Philippine and Molucca Pacific islands); close to each of the southern parts is a satellite island with a most remarkable aberrant fauna—Madagascar, New Zealand, and Galapagos Islands. These three continents would geologically be considered three different formations. Australia, probably the youngest continent, representing the Liassic period of the Old World, is characterized by the lowest Mammalia, viz. the abortive Marsupialia. America has only a few Marsupialia, frequently without pouch (marsupium), but the greatest number of the lowest Placentalia (Microsthena), the Edentata. Africa has no Marsupialia, but a few Edentata, and abundance of the higher Mammalia (Macrosthena). If an order is common to the Old and New Worlds, there is always a marked difference according to the continent, the species of the Old World belonging to groups of a superior stamp. Thus the Quadrumana and Scansores (Parrots, among birds, corresponding with Monkeys) are divided into those of the Old and those of the New World —the latter being chiefly long-tailed, a character considered inferior.

The *Ampullariæ* of the New World are nearly all provided with a siphon, which is wanting in those of the Old World. The same is the case with the genus *Polymesodon* in the *Cyrenidæ*, and *Leila* among the *Unionidæ*. The difference between the faunæ of the three continents diminishes towards the north, where the faunæ are fused into one circumpolar fauna, like the three continents themselves. The land-faunæ are limited by thermal differences or mountain-ranges. Species living in or or close to water (e. g. *Succinea*) are very similar all over the world.

The three continents above mentioned divide the ocean into three parts geographically, but not zoologically—the Atlantic, the Pacific, and the Indian oceans. These are limited by the following coast-lines:—

1. From Behring's Straits, Norway, Spain, Guinea, Cape.

2. From Behring's Straits, Greenland, Florida, Brazil, Cape Horn.
3. „ Oregon, California, Peru, Cape Horn.
4. „ Kamtschatka, Japan, China, Tasmania.
5. Cape, Arabia, India, Sumatra, Tasmania.

The three first-named coast-lines may zoologically be considered the boundaries of the Atlantic Ocean, in the same way that America is considered an island in the Atlantic Ocean, separated from the Pacific Ocean by the western edges of the polar streams and the great abyss between the Galapagos Islands and the Sandwich Islands. The coast-lines are divided into analogous faunæ according to the climate: 1. Polar; 2. Subpolar (North Sea); 3. Subtropical (Mediterranean); 4. Tropical (Guinea). The southern polar and subpolar are not sufficiently known (Kerguelen Island, St. Paul's, &c.).

It would seem easy for most animals, even for Mollusca, the young of which generally are natatory, to move or to be carried by currents from one end of these coast-lines to the other; but in reality this is not the case. The temperature of the sea seems to put a nearly insurmountable barrier to the distribution or migration of species, and even of genera. A general view of those faunæ shows that they are composed of animals of all subkingdoms, classes, orders, families of the animal kingdom (Gulls, Seals, &c). The genera are often different, although allied; and the species are nearly always different in each fauna. The question now arises, Are these species and genera originally different, or changed by various physical causes, such as climate, light, the saltness of the sea, &c.? The influence of these causes on the form and size of shells is chiefly seen by comparing the faunæ of the Baltic and Mediterranean with that of the ocean.

It would be a very slow process to compare the species of all these faunæ, chiefly because no museum possesses a sufficient collection of animals in spirits for investigation of the teeth, even of European species. The specific importance of the teeth is evident, chiefly from the researches of Troschel; many species which were considered slight varieties are now proved to be distinct—e. g., *Natica millepunctata* and *N. maculosa*, *Natica clausa* and *N. consolidata*, &c., &c., *Viviparus contectus* and *V. fasciatus*, *Bithinia ventricosa* and *B. tentaculata*.

The genus *Aporrhais*, which was abundant in former geological periods, from the Oolitic formation upwards, is now restricted to five or six recent species inhabiting the Atlantic only. *Aporrhais occidentalis* is found on the coast of Canada

and Greenland. *A. pes-pelecani* and a variety, perhaps specifically distinct, are found from the north of Norway to the Mediterranean. In Shetland a second species is added, the *A. pes-carbonis*, which in the Mediterranean is represented by *A. Serresiana*, Phil. In Senegal is found *A. senegalensis*, Gray. The most northern species is the largest of the genus, as is generally the case; the outside of the outer lip is smooth, as in all other arctic univalves. In *A. pes-pelecani* and the following southern species the inside lip is plaited, as is generally the case in species of warmer climes (e. g. *Nassa* and other univalves). The *A. senegalensis*, living in the hottest water, is the smallest. Unfortunately it will be very difficult to get the tongues of these species. The teeth of *Aporrhais pes-pelecani* as represented by Lovén, Troschel, and Wilton differ considerably from one another, making it probable that two species are confounded.

A monographic research, chiefly based on the teeth of the genera *Nassa*, *Fusus*, and *Buccinum*, found on the coast-lines from the arctic regions to the equator, would probably be sufficient to prove whether species in each fauna are created originally or are only varieties dependent on different climates, and would at the same time prove the relations between the species of succeeding geological periods.

Large suites of specimens, from various depths and localities, are in most cases sufficient to prove the difference or identity of so-called species, without a knowledge of the animals; but the affinity of the genera and families can only be safely understood by anatomical researches: the anatomical as well as the zoological characters are, however, generally either misunderstood or overvalued. I will therefore endeavour to show the relative systematic value of the various organs of the Mollusca. Until these questions are quite cleared up, it will not be possible to solve the problem in regard to the origin of species among the Mollusca.

Cuvier founded his primary divisions (classes) of the Mollusca on the locomotive organs, viz. Cephalopoda, Pteropoda, Gasteropoda, Acephala (this last changed by Oken to Pelecypoda), Brachiopoda, and Cirrhopoda. The group Heteropoda, correctly considered by Cuvier only a family, was by most subsequent naturalists considered of the same value as the above-mentioned divisions. The study of the homology of the parts of the Mollusca, commenced by Professors Lovén and Huxley, has shown that the Pteropoda are true Gasteropoda, and that the funnel of the Cephalopoda is homologous with the foot of the Gymnosomata. Such a system seems to me to correspond with that classification, by the old authors, of the Vertebrata (Quadrupeda, Bipeda, Pinnata, and Apoda), maintained so pertinaciously by Klein in

opposition to the Linnæan system founded chiefly on the anatomical researches of Ray. The Cetacea, but chiefly the Reptiles (*Anguis, Bipes,* &c.), afford striking examples of the insignificance of the locomotive organs as a base for the primary divisions.

The secondary divisions (orders) of Cuvier were founded on the respiratory organs. Respiration is indispensable for the life of all organic beings; but special organs for this purpose are not always necessary. Respiration of some importance takes place through the skin, even in the higher Vertebrata, and can, in the lower Vertebrata (*e. g.* Batrachians), temporarily replace that through the lungs: it is quite sufficient for many Mollusca.

The Vertebrata have two kinds of respiratory organs—lungs, and gills—which, according to J. Müller, are not homologous, as they can be found together in the same individual, although not always exactly performing the same function—for instance, the Batrachians and the fœtus of the higher Vertebrata. In fishes the lungs are reduced to a swimming-bladder, the walls of which are provided with some bloodvessels, making it serve as a secondary, but very imperfect, respiratory organ comparable to the lung-sac of the Pulmonata. That this organ, even among the Mollusca, cannot be homologous with the gills, as advanced by Prof. Agassiz *, is proved in *Ampullaria* and perhaps *Onchis*, each of which has lung-sacs simultaneously with true gills. Many Mollusca (as *Cyclostoma, Neritina,* and *Littorina*), which are undoubtedly provided with gills, live always or nearly always in the air, probably having the power of keeping their gills moist, like the Land-crabs and several fishes (e. g. *Anabas scandens*). Whether the vena branchialis and vena pulmonalis are identical is at least not yet proved. In Mollusca not requiring a hard covering for their protection, respiration takes place through the skin; but when the skin is thickened, or a shell developed, a respiratory organ becomes necessary. The use of the gills is to produce, by the complication of a part of the skin, a surface corresponding with the area made impenetrable to the oxygen of the surrounding medium (air or water). The effect of this dermal gland is increased by vibratile cilia, producing a swifter circulation of the oxygeniferous medium. If the branchial sac is very deep, the circulation of the water is effected by a siphon acting like a chimney-pipe, often assisted by muscular contractions (Cephalopoda, Acephala). The larger the shell is in proportion to the uncovered parts of the animal, the more complicated and compressed are the gills.

Several of the internal glands are subject to the same change.

* "On the Circulation of Fluids in Insects," Proc. Bost. Soc. 1850, p. 237.

Thus the liver is strongly arborescent in animals having a dermal respiration (Pellibranchiata, Gymnobranchiata), and becomes more and more compressed in proportion as the gills are developed (*Scyllæa, Pleurophyllida*); but it is most complicated in Mollusca covered with a shell. The same is the case with the renal organ, which becomes rounded and spongy, as is to be seen in the plates of Mr. Hancock's excellent paper* on the renal organ of nudibranchiate Mollusca, and in the work of Gegenbaur† on the Heteropoda and Pteropoda. The compact structure of this organ in the testaceous Mollusca may be seen in many of the plates to the 'Voyage de l'Astrolabe.'

In the Pellibranchiata the generative glands partake of the arborescent form of the liver and kidney: thus in *Elysia* ‡, &c., the albuminous gland, the hermaphrodite gland, and "la glande en trèfle" of Moquin§ are strongly arborescent.

The dorsal plates of *Placobranchus* and the arborescent tufts of *Dendronotus* and *Onchis* may be considered the most imperfect forms of gills. The hepatic papillæ of the *Æolididæ* are probably not homologous with the branchial leaves of Gasteropoda (e. g. *Ianthina, Pterotrachæa, Doris*), as these organs in *Bornella* are found simultaneously with arborescent tufts of the skin, which may be considered homologous with the branchiæ of the *Doridida*. There appears to be a gradual transition in the respiratory organs of *Tritonia, Heptabranchus, Hexabranchus,* and *Lamellidoris*. It must, however, be remembered that, according to Dr. Hancock, the gills of *Doris* receive hepatic blood. The gills in symmetrical animals are generally situated on each side of the body, *e. g.* Acephala, Cyclobranchia, Inferobranchia. In asymmetric spiral testaceous Mollusca the single gill becomes smaller, and is said to be reduced to a filiform undulated vessel, as in *Vermetus* and *Onustus* ||. I have observed, however, in a specimen of *O. trochiformis*, that this vessel opens through a pore on the outer side of the mantle opposite to the shell; it may perhaps be in some relation with the renal organ.

The insignificance of the gills as a systematic character is evident by comparing the Heteropoda, from the entirely gill-less *Firoloides* and *Pterotrachæa* with external gills, to *Atlanta* exhibiting perfectly internal gills. The same fact is to be seen in the following series of allied genera:—*Stylochilus, Notarchus, Aplysia, Bulla,* &c., *Actæon, Odostomia,* and *Obeliscus*.

* Trans. Linn. Soc. 1864.

† Untersuchungen über die Pteropoden u. Heteropoden, 1854.

‡ Journal de Conchyliologie, vol. i.

§ "Le talon" (St. Simon) = "petite glande sécréteur" (Souleyet, *l. c.* t. 6. f. 5).

|| Mörch, Journal de Conchyliogie, vi. p. 308.

These two series prove not only that the size and form of the gills stand in connexion with the development of the shell, but that the divisions Opisthobranchiata and Prosobranchiata, as originally proposed, are not natural; this has been indicated by Messrs. Huxley and Macdonald.

The two kinds of respiratory organs indicate only relative superiority and inferiority, but not limits of systematic divisions. Thus, among Vertebrata, lungs and gills meet in a family of the Batrachians. Among the Mollusca, it is probably in *Auricula* and *Obeliscus* that the two kinds of respiratory organs are found to meet.

It has been generally understood that neither the locomotive nor the respiratory organs offer characters for the primary divisions; most authors have therefore divided the Mollusca, according to the presence or absence of a distinct head, into Cephalophora and Acephala. As several Gasteropoda (*e.g.* Thecosomata) properly have not a distinct head, Prof. Lovén has changed the names to Glossophora and Aglossa. Cephalization, as explained by Prof. Dana, is, no doubt, of importance as a character indicating relative superiority and inferiority, but is not sufficient for natural divisions. Thus, according to this principle, the Vertebrata would only be divided into two classes, 1. Cephalophora with a distinct head—Mammalia, Birds, and Reptiles; 2. Acephala, with the head united to the thorax, containing the Fishes only.

My study of the Mollusca for about twenty years enables me to state that the heart and generative organs offer characters of a much higher systematic value than is generally believed. It is perhaps somewhat hazardous to compare the organs of the lower animals with those of the higher; but it does not seem probable that organs which have no systematic value in the higher can have it in the lower animals.

The accompanying synopsis of the Mollusca is chiefly founded on the intromittent male organ, which seems to me to be the best indicator of the sensibility of the nervous system, and consequently of the relative systematic rank of the animal. Thus the lowest class of Vertebrata (the Fishes) wants an intromittent male organ, although the sexes, with few exceptions, are separate; there exists, consequently, no copulation, but impregnation takes place as among plants. In the Plagiostoms the posterior locomotive organs of the male are changed into conduits for the sperm*, like the hectocotylized arm of the Cephalopods. In the Batrachians the anterior locomotive organs are used as prehensile organs during the pseudo-copulation; but a true

* Steenstrup, Om Hectacotyldannelsen, p. 26, Kgl. Danske Videnskabernes Selskabs Skrifter, 5. Række, 4. Bind.

male intromittent organ is first found among the Reptiles, and becomes more and more developed among the higher Vertebrata.

That this fact is not in consequence of aquatic habits is evident by comparing the Cetacea and Sea-serpents, which are provided with a true male organ.

A similar fact may be observed among the Articulata, of which the Insects only may have a true male organ.

Among the Mollusca the Androgyna are provided with the most developed male organ, and which seems to be the most sensitive. The male organ of the Exophallia is always external, not retractile, sometimes concealed in a furrow of the right tentacle (e. g. *Viviparus*). The Pseudophallia have no male organ*. The copulation is probably effected in the same way as among Batrachians; but direct observations are wanting. The male Acephala disperse their sperm, which is taken up by the females like the pollen by flowers. The few observations on the copulation of Acephala are very problematical. My synopsis confirms the rule of Prof. Agassiz that land-animals are more perfect than marine; but this rule may be explained in the sense that the divisions with the largest number of terrestrial forms always are the superior. Thus, among the Vertebrata, the Thermalia† are higher than the Psychræmia, containing the greatest number of aquatic forms. The lowest class, Acephala, is entirely aquatic and chiefly marine. Among the Pseudophallia, *Helicinæ* are the only terrestrial, and *Neritinæ* fluviatile. The number of terrestrial genera is considerably increased among the Exophallia; thus *Cyclostomaceæ* are truly terrestrial, *Ampullariæ*, *Paludinæ*, *Melaniæ*, and *Potamidæ* fluviatile. Among Androgyna are the greatest number of terrestrial genera.

There is the same concordance with the law of Prof. Owen, "that the multiplicity of organs indicates inferiority in organization." As was shown in a former paper, the duplicity of the organs of Acephala descends as the system ascends.

The development of the young is of less systematic value than is generally believed: this is proved in the Crustaceans, the marine species having a larval form very different from the fluviatile species (*Astacus fluviatilis* and *A. marinus*). All larvæ of marine Mollusca swim by means of a velum, which in the marine Acephala, *Chiton* and *Dentalium* is changed to a flagellum. In the melicertigene Gasteropoda (Rhachiglossata) the larva loses the velum before it leaves the egg-case. The larva

* In the 'Voyage de l'Uranie' is represented a *Neritina* with something like a short male organ between the mouth and right tentacle, but which seems not to have been observed in the European species.

† The difference between hot- and cool-blooded animals seems not to be sufficiently insisted upon in the modern systems.

of *Auricula* agrees with that of marine Mollusca, according to Dr. C. Semper, although the most allied forms (*Limnæa*) are not subject to this kind of metamorphosis.

All the terrestrial forms leave the egg in a perfect state. The Cephalopoda may be considered Gasteropoda stopped in the larval stage, reminding one of *Macgillivrayia*. The number of the eggs may also be of some importance for the determination of superiority and inferiority, as nature seems to compensate want of intelligence, or power to provide for the offspring, by great fertility: thus plants are more fertile than animals; the Helicea produce but few eggs compared with the Acephala. Since the time of Cuvier nearly all naturalists have considered the Cephalopoda the highest type of Mollusca, chiefly on account of a presumed affinity with the Fishes, their great size, great muscular power, as well as the apparent superiority of the nervous system and organs of circulation. Naturalists are not yet agreed which families may be considered the highest in each class, except in the Mammalia. Among the Birds, the Parrots are considered the highest by the best authors; the Serpents may perhaps be the highest Reptiles, although such an authority as Prof. Agassiz considers the Chelonians the highest, on account of the completeness of the ossification. According to this principle, the Edentata would be the highest Mammalia! The largest and strongest Arthropods, the Lobsters, have a similar claim to be considered the highest of that subkingdom. Marine animals are always larger than their kindred on the land, but not the most perfect, as Prof. Agassiz has proved.

The systematic place of the Cephalopoda may depend on the structure of the heart and the explanation of the hectocotylized arm as a male organ. If the branchiocardiac veins of Cephalopoda may be considered auricles, as stated by Milne-Edwards, Kölliker, Huxley *, and Gegenbaur †, the place of the Cephalopoda must be between *Dentalium* and Acephala ‡—a place not more strange than that of the *Cæciliæ* standing before the Plagiostomes, or the *Linguatula* before the Decapod Crustacea.

The hectocotylized arm of the male indicates a kind of copulation between two individuals, giving the Cephalopoda claim to a higher place than the Acephala; but it must be remembered that the manner of copulation of the Pseudophallia is entirely unknown at present.

If the cardiac auricles only prove to be tumefactions of the

* On Morphology, &c. p. 57—"the *presumed* highest Mollusca."

† Vergleichende Anatomie, p. 375.

‡ *Solen* swims, according to Prof. Deshayes, like the Cephalopoda, by driving water out of the respiratory cavity.

branchiocardiac veins, the Cephalopoda must then be removed, according to the septiserial teeth of the tongue, to the Tænioglossata, the larvæ of which (*Macgillivrayidæ*) are not unlike the Cephalopoda. This position would answer to that of Cetacea being united by the Sirenians to Pachydermata.

The pelagic Cephalopoda are certainly the most powerful and ferocious of all Mollusca, like the Sharks and Cachalots among Vertebrata; but in the same divisions are found large animals living on small animals (*e. g.* the Whalebone-Whale and the *Squalus glacialis*). The same is probably the case with the largest of all Cephalopoda, *Architeuthis dux*, Stp. The two mandibles of the Cephalopoda are generally very powerful and very conspicuous; but their little value as a character for a class is best seen by the two divisions of mandibulated Echinodermata and the Helicea. The eyes offer the same differences as in other parts of the animal kingdom, being small in the diurnal species and larger in the nocturnal. The size of the lens cannot be considered a character of perfection of the visual organs, because the fishes would in such case have the most perfect eyes among Vertebrata. *Nautilus* wants a lens, according to Prof. Keferstein. The exterior form of Cephalopoda is a combination of the form of the Fishes and Radiata*, depending on their manner of locomotion. *Cirroteuthis* has thus a striking resemblance to a *Medusa*. The Cephalopoda seem to me not to have more just claims to be considered a distinct class in relation to the other Mollusca than Pteropoda or the Cetacea among Vertebrata. They exhibit a remarkable analogy with the Plagiostomes in their habits, in the male organ, the manner of depositing their eggs, and in the yolk-bearing young.

Subkingdom III. MOLLUSCA.

Series I. *MONOTOCARDIA.*

The heart with a single auricle. Copulation between two individuals.

Class I. ANDROGYNA (Musivoglossata *olim*).

All individuals alike in respect of the sexual organs, having the two sexes united. Always provided with a receptaculum seminis (petiolate bladder). Male organ retractile. Teeth of the tongue generally multiserial. Predominantly mandibulated.

Pulmonata.

Geophila: Phyllovora, Agnatha†.

Hygrophila: *Planorbis, Physa, Limnæa, Siphonaria, Ancylus, Auricula.*

---

* Owen, Proceedings of the Zool. Society, 1836, p. 19.

† Journal de Conchyliologie, July 1865.

TECTIBRANCHIA: *Pyramidella, Obeliscus, Odostomia, Chemnitzia, Actæon, Bulla, Aplysia, Notarchus.*

PTEROPODA: Gymnosomata,—*Clione, Pneumodermon* (*Ianthina*?); Thecosomata,—*Clio, Hyalæa,* &c.

GYMNOBRANCHIA.

1. Pygobranchia: *Doridæ,* &c.
2. Pleurognatha: *Pleurophyllidia, Dendronotus, Tritonia, Bornella, Æolis, Glaucus,* &c.
3. Pellibranchia: *Tethys, Chionera, Hermæa, Elysia, Limapontia, Pelta,* &c.

Class II. EXOPHALLIA (Arthroglossata *olim*).

Sexes distinct; male organ not retractile (often concealed in the branchial cavity or in the tentacle). Mouth predominantly suctorial. Lingual strap not having more than seven rows of teeth.

TÆNIOGLOSSATA. Tongue with seven rows of teeth, with reflected edge. Larva of the marine species swimming.

A. *Rostrifera.* With a short muzzle, not retractile.

α. terrestria. Cyclostomacea (*Truncatella*).

β. fluviatilia. *Ampullaria, Paludina, Melania, Potamides, Cerithium, Turritella* (with nine? rows of teeth), *Littorina, Lacuna, Velutina, Onchidiopsis.*

γ. parasitica. The eggs hatched in pouches attached to the inside of the shell. *Vermetus, Crepidula, Hipponyx, Capulus.*

δ. Pelagica Heteropoda. *Firoloides, Pterotrachæa, Cardiapoda, Peltaria*, Carinaria, Helicophlegma, Atlanta, Bellerophon, Onustus.*

ε. *Strombi.*

B. *Proboscidifera.* Rostrum retractile. *Natica, Ovula, Pedicularia, Trivia, Cypræa, Cassis, Dolium, Pyrula, Triton, Trichotropis, Aporrhais.*

RHACHIGLOSSATA. Tongue not having more than three rows of teeth, which are not reflected at the edge. Rostrum long, retractile (without cheek-plates?). Eggs deposited in cartilaginous capsules, which the young leave when the metamorphosis is complete. *Marginella, Voluta* (lateral teeth absent), *Harpa, Oliva, Ancillaria, Bullia, Nassa, Buccinum, Fusus, Fasciolaria, Turbinella, Murex, Purpura* (*Magilus*?), *Mitra.*

TOXOGLOSSATA. Mouth with a suctorial veil. Tongue (?) with subulate teeth provided with an internal or external veniferous canal. *Conus* (*Borsonia*?), *Pleurotoma, Clionella,* making a transition to *Terebra, Cancellaria.* The egg-cases of this division are probably like the preceding; but direct observation is wanting.

Series II. *DIOTOCARDIA.*

Heart with two auricles. (That this character has no relation to the position of the gills, as Prof. Huxley suggested, is evident in the case of *Pleurophyllidia,* which, according to Messrs. Hancock and Bergh, have

* *Carinaria depressa,* Rang, Man. t. 3. f. 1.

a single auricle, although the gills are lateral—and because *Turbo marmoreus*, with a single gill, has two auricles, according to Quoy and Gaimard.) Sexes distinct, but without male organ.

Class III. PSEUDOPHALLIA (Aspidobranchia *olim*).

Tongue with the lateral teeth of two different forms. Male organ rudimentary? Development only known in *Chiton* and *Dentalium*.

Rhipidoglossata. Median teeth broad, with reflected edge, generally 5.1.5; marginal teeth compressed; these are very numerous, with inflected tips.

Terrestria. *Helicina*. (Eyes sessile.)

Fluviatilia. *Neritina*. (Eyes petiolate.)

Marina. *Nerita, Turbo, Trochus, Haliotis, Fissurella, Emarginula*. (Eyes sessile.)

Heteroglossata. (Dochoglossata, *Troschel*). Tips of the teeth (always?) having a black pigment. The marginal teeth of the preceding division are absent.

Cyclobranchia. *Patella, Tectura*.

Polyplacophora. *Chiton, Chitonellus*.

Cirrobranchia. *Dentalium, Siphonodentalium*.

Cephalopoda.

1. *Dibranchiata*.
   A. *Octopoda*.
   B. *Decapoda*.
      Oigopsidæ.
      Myopsidæ.
2. *Tetrabranchiata*. *Nautilus*.

Class IV. ACEPHALA (Dithyra).

Dimyaria.
Heteromyaria. *Mytilacea* et *Ostreacea*?
Monomyaria. *Pecten, Spondylus, Lima, Tridacna*.

Observations.

Ianthina has perhaps the same relation to *Pneumodermon* as *Carinaria* to *Pterotrachæa*. *Ianthina* has a pair of epipodial fins. Dr. Gould has represented (American Exploring Expedition) some aciculate bodies, probably homologous with the hooks on the arms of *Pneumodermon*. The latter genus has, according to D'Orbigny, a small hump on the back, probably a rudimentary mantle; but intermediate genera are yet unknown.

The Thecosomata differ considerably from the Gymnosomata. I find it at least very doubtful whether *Eurybia* makes a true transition between the two divisions. The Thecosomata have 3–5 band-like lateral mandibles, and a triseriate lingual dentition, quite different from that of the Gymnosomata. According to Souleyet, they have a petiolate bladder, and are consequently

androgynous; but they are perhaps more nearly allied to *Gasteropteron* or the *Bullidæ*. The systematic position seems to me not sufficiently clear.

The relation between the pulmoniferous *Auricula* with a marine larva and the marine branchiferous *Pyramidella* requires further observation. Quoy and Gaimard have pointed out their affinity.

The relation between a rostrum (not retractile) and a proboscis or haustellum (retractile) is not yet sufficiently understood. Perhaps there is no other difference than between a long and short siphon. *Strombus* appears to make a transition between the two, and seems to approach most to *Cypræa*.

XLIII.—*Description of four new Species of Butterflies in the Collection of the British Museum.* By A. G. Butler, F.Z.S., Assistant, Zoological Department, British Museum.

1. *Anthocharis Leo.*

Upperside—*front wings* snowy-white, with a pale orange patch on the inner margin, bounded above by the third median nervule; base greyish; apex and a subapical line grey; nervures black: *hind wings* snowy white, suffused with orange on the front margin.

Body grey; head and prothorax yellowish.

Underside white, tinted with ochreous, darker at the apex of front wings and front margin of hind wings; a curved line of small indistinct brown spots crosses the hind wings just below the middle.

Expanse of wings 1 inch 9 lines.

Hab. White Nile.

2. *Danais Mariana.*

Upperside—*front wings*, basal half, an irregular subapical band, a small spot on the costa just beyond the middle, and two marginal spots between the median nervules sap-green; apical half and nervures rich brown, its inner outline angularly and irregularly notched: *hind wings*, basal half sap-green, tapering towards the termination of the upper disco-cellular nervule, with an angular and irregular outline; apical half and inner marginal nervures rich brown; other nervures reddish.

Body brown; head reddish, spotted with white; antennæ black.

Underside—*front wings* as above, but with three additional small marginal green spots and paler-coloured nervures; *hind wings* as above, but with two submarginal rows of pale-green spots placed in fours between the nervures along the hind margin, and the nervures margined with brown.